

**Complete simulation of the HF re-calibration
with the radioactive source: readout method
and the precision of measurement**

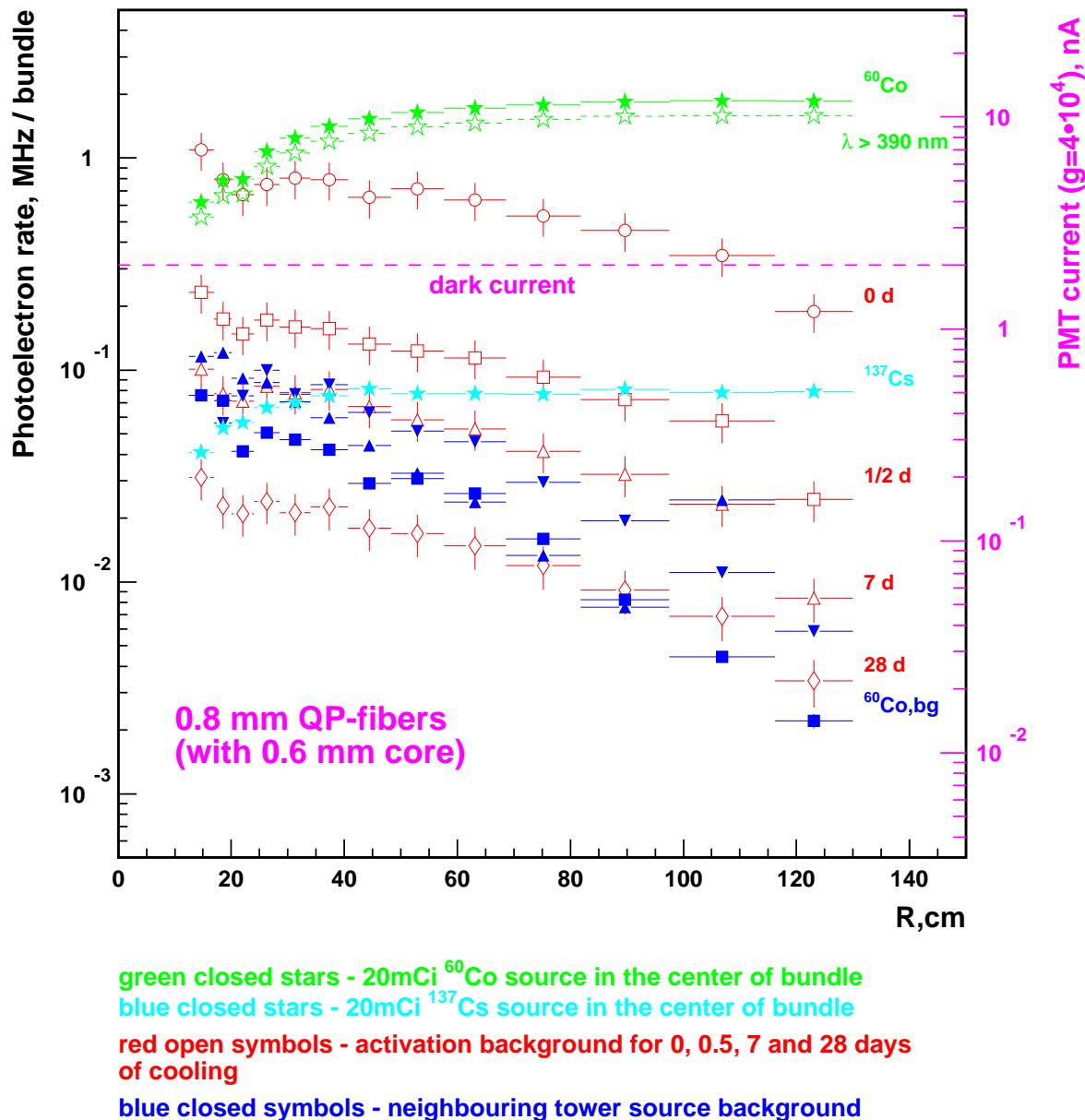
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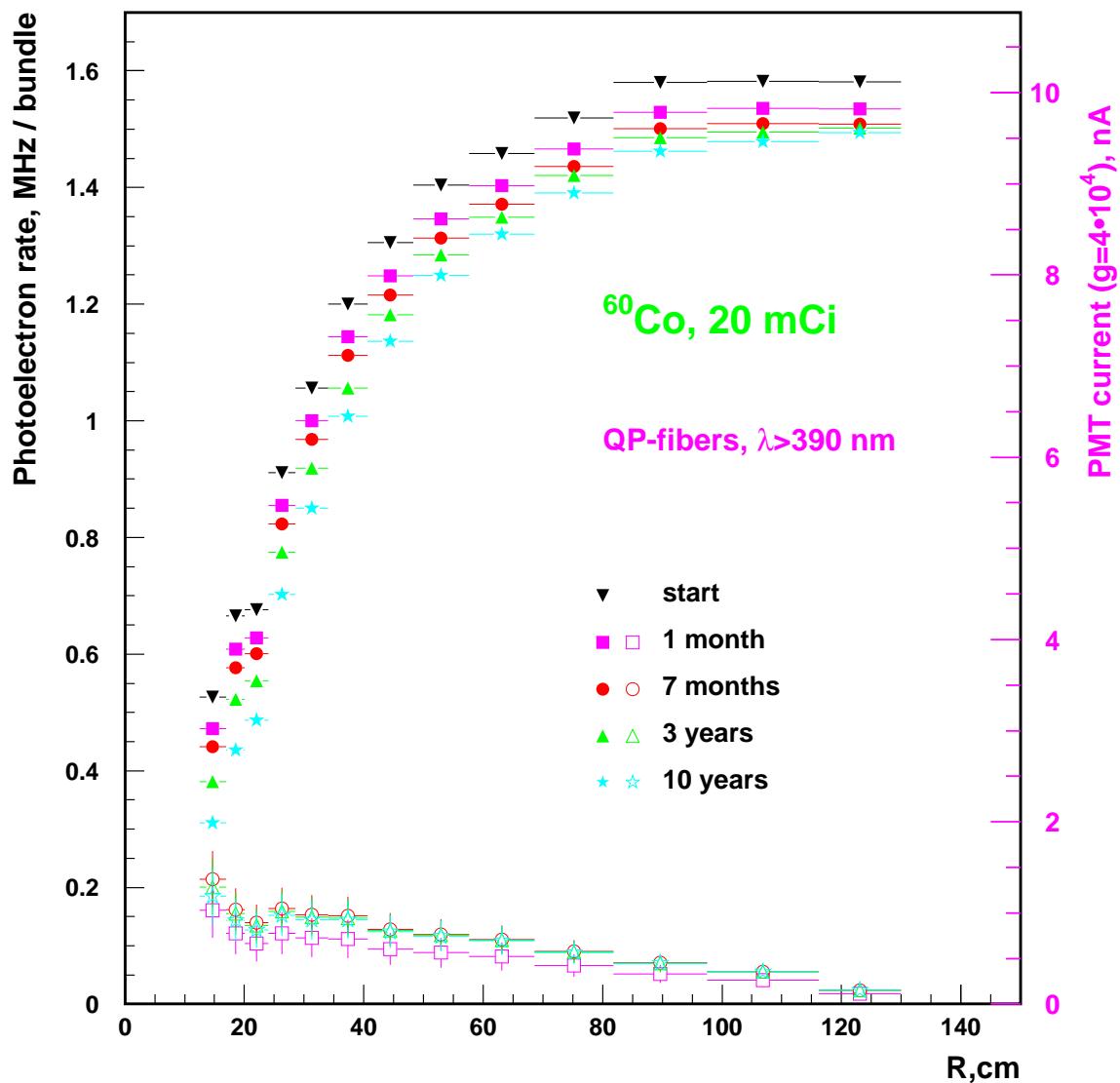
*Calibration and Monitoring
for CMS Calorimeters
RDMS working group*

CERN, September 2001

Photoelectron rates and PMT currents



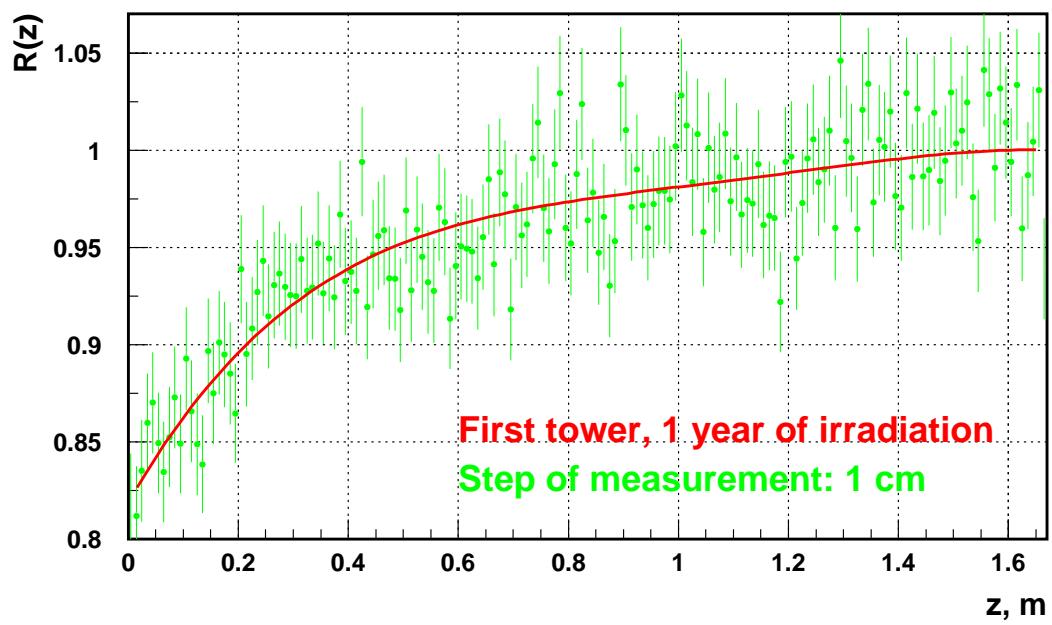
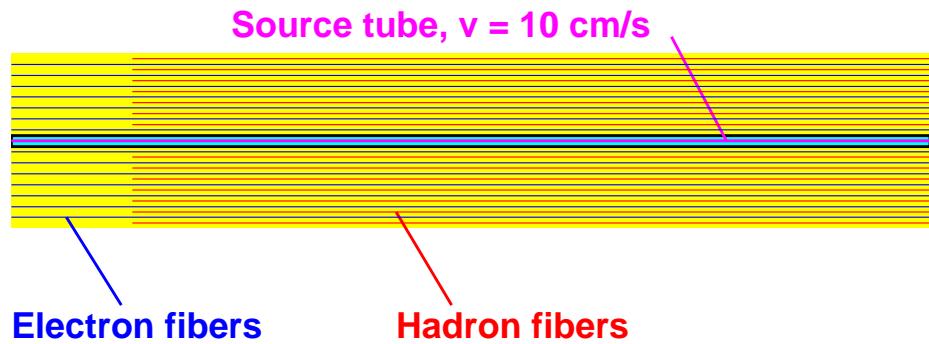
Dynamic of the source signal



Closed symbols - cobalt source signal

Open symbols - activation background signal

Scheme of the HF re-calibration with the source



Main steps of the CMS HF re-calibration using radioactive source:

Before irradiation:

- apparatus background measurement ($A_b(t_0, r)$)
- radioactive source response measurement ($A_{s+b}(t_0, r, z)$)

After irradiation:

- apparatus + activation background measurement ($A_{b+a}(t, r)$)
- radioactive source response measurement ($A_{s+b+a}(t, r, z)$)

The fiber transparency reduction coefficient is calculated as:

$$R(t, r, z) = \frac{(A_{s+b+a}(t, r, z) - A_{b+a}(t, r))}{(A_{s+b}(t_0, r, z) - A_b(t_0, r))}$$

and $R(z)$ is fitted by 4-degree polynomial

Monte-Carlo test of the re-calibration procedure:

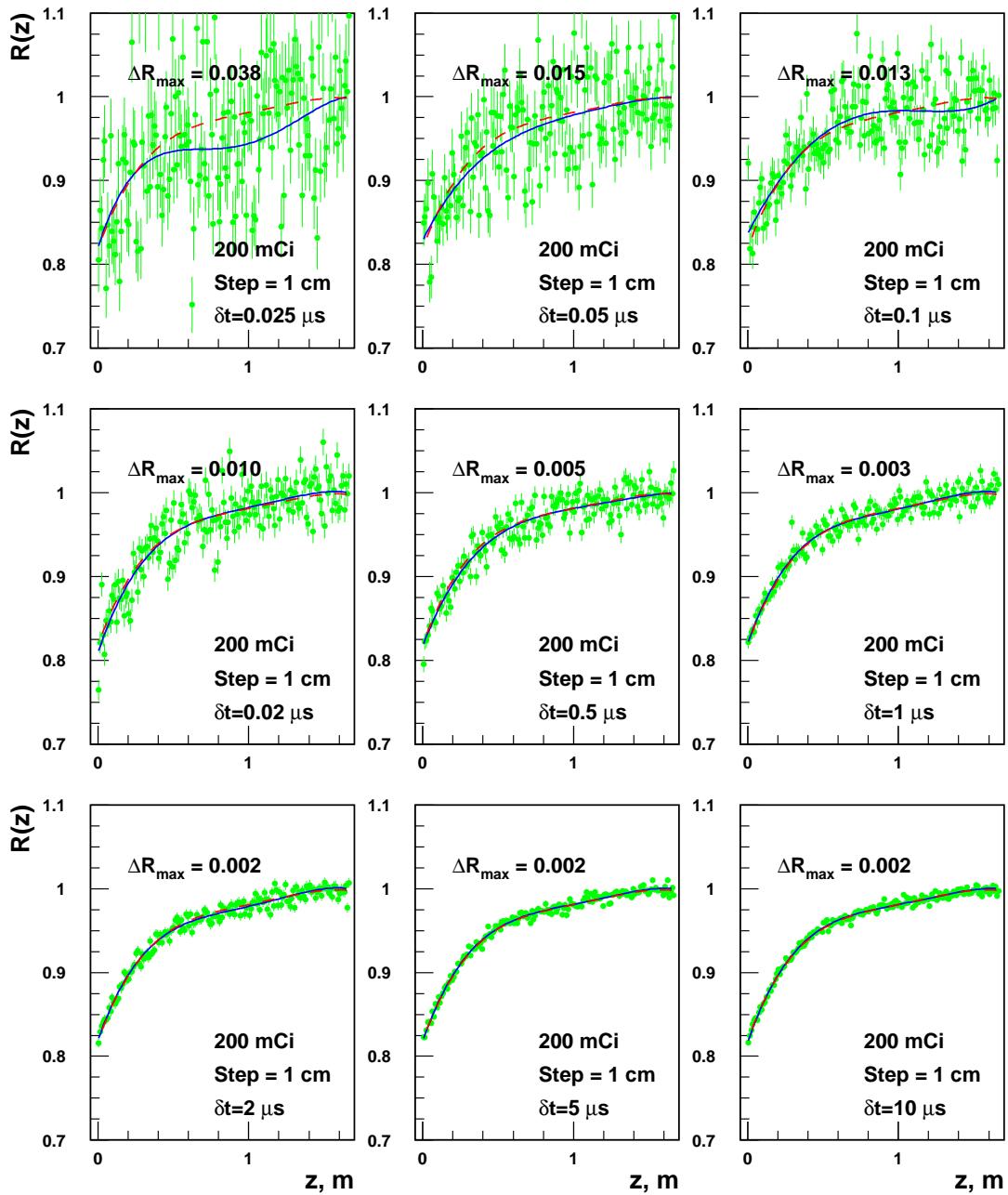
- tower number 1,
- one year of irradiation,
- 1/2 days of cooling,
- radioactive source and activation background count rates are taken according to the previous M.-C. data.

^{60}Co source is running with the constant speed $v = 10 \text{ cm/s}$

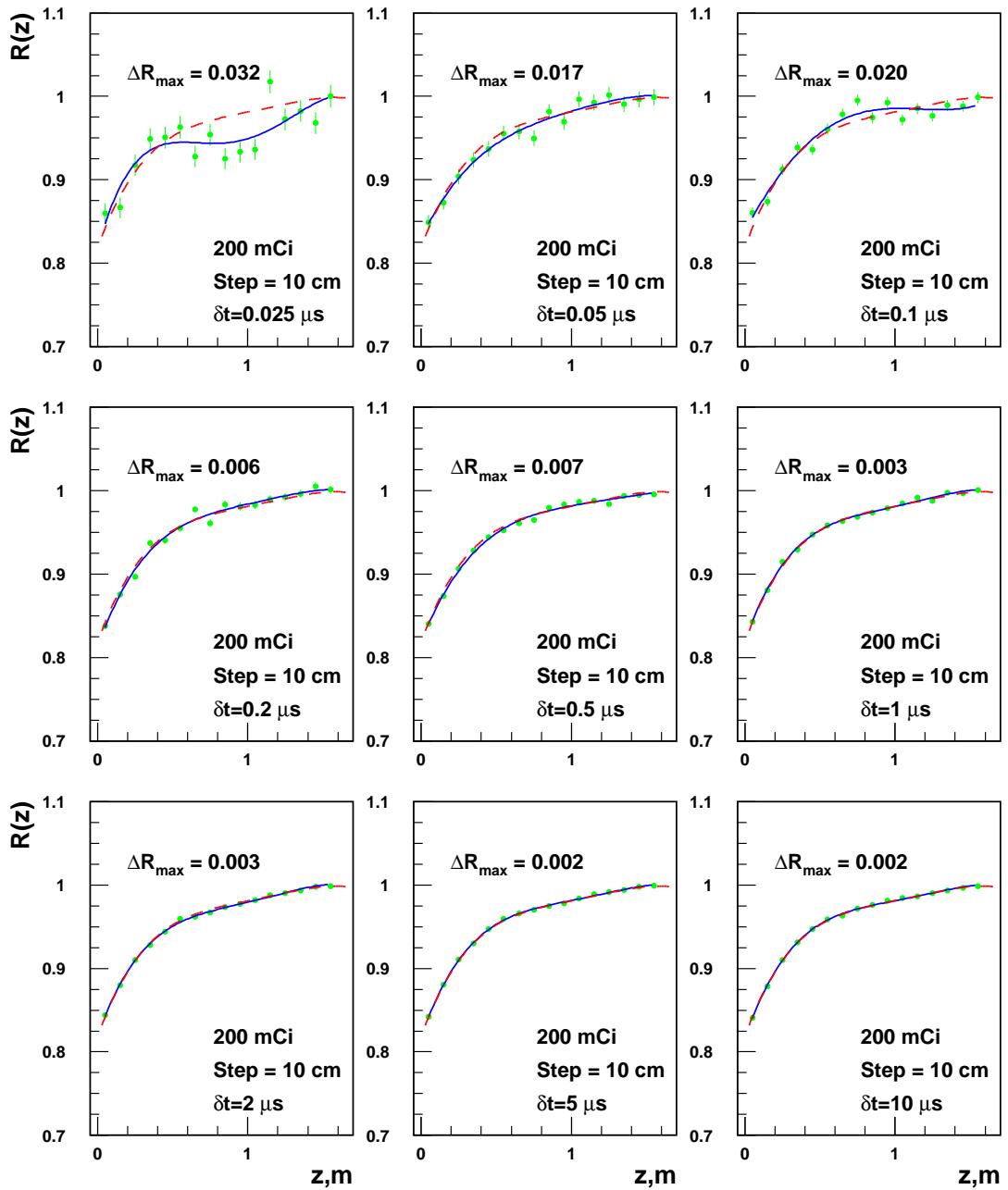
Parameters of readout system (PMT and electronics):

- PMT gain $g = 4 \cdot 10^4$,
- PMT dark current $I_d = 2 \text{ nA}$,
- maximal readout frequency $f = 100 \text{ kHz}$,
- ADC time gate (or other integration time) is considered as variable from 25 ns (standard ADC gate) to 10 μs (current mode of measurement),
- ADC pedestals is considered as Gaussian.

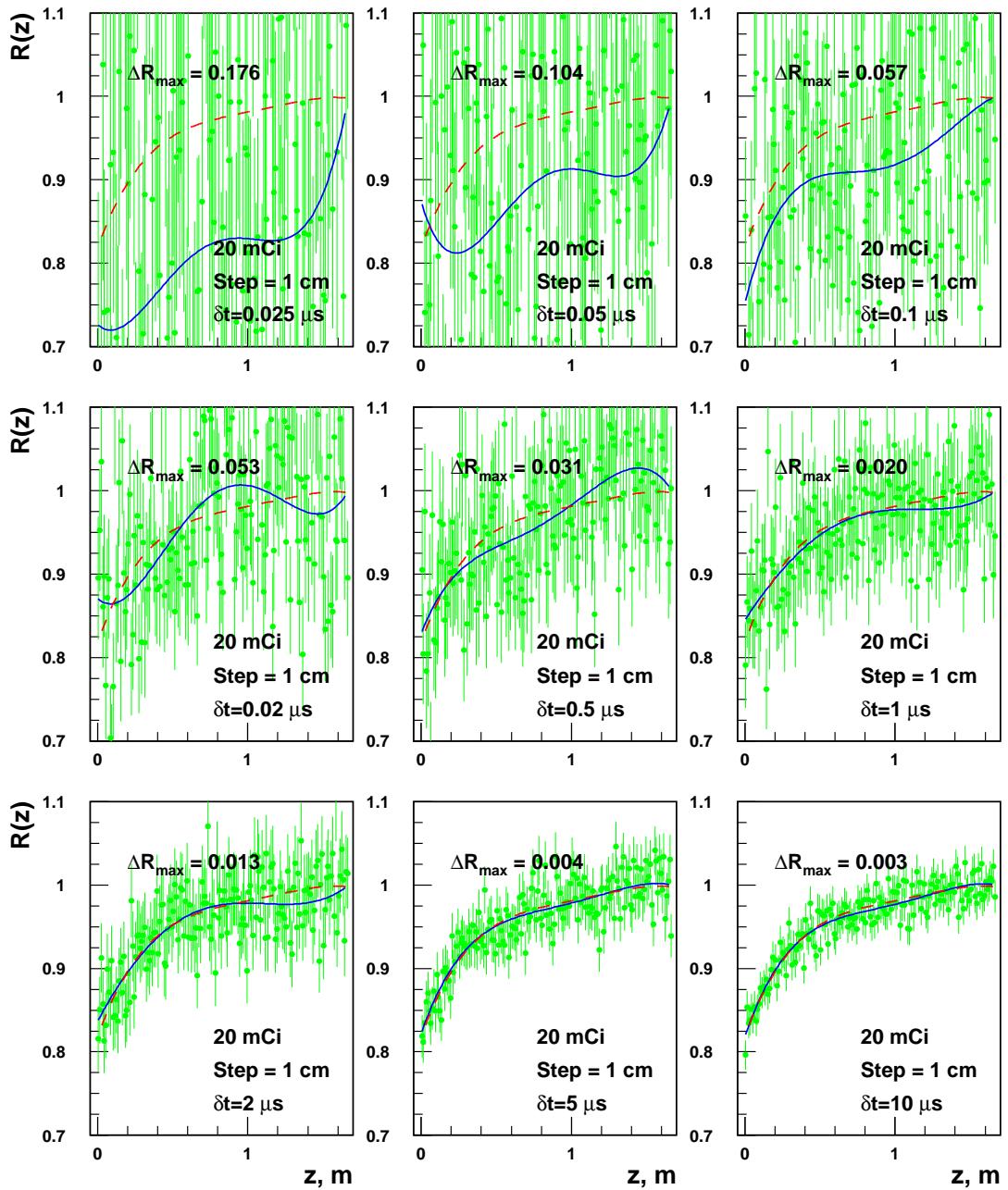
Measurement of the fiber transparency reduction (200 mCi, 1 cm step)



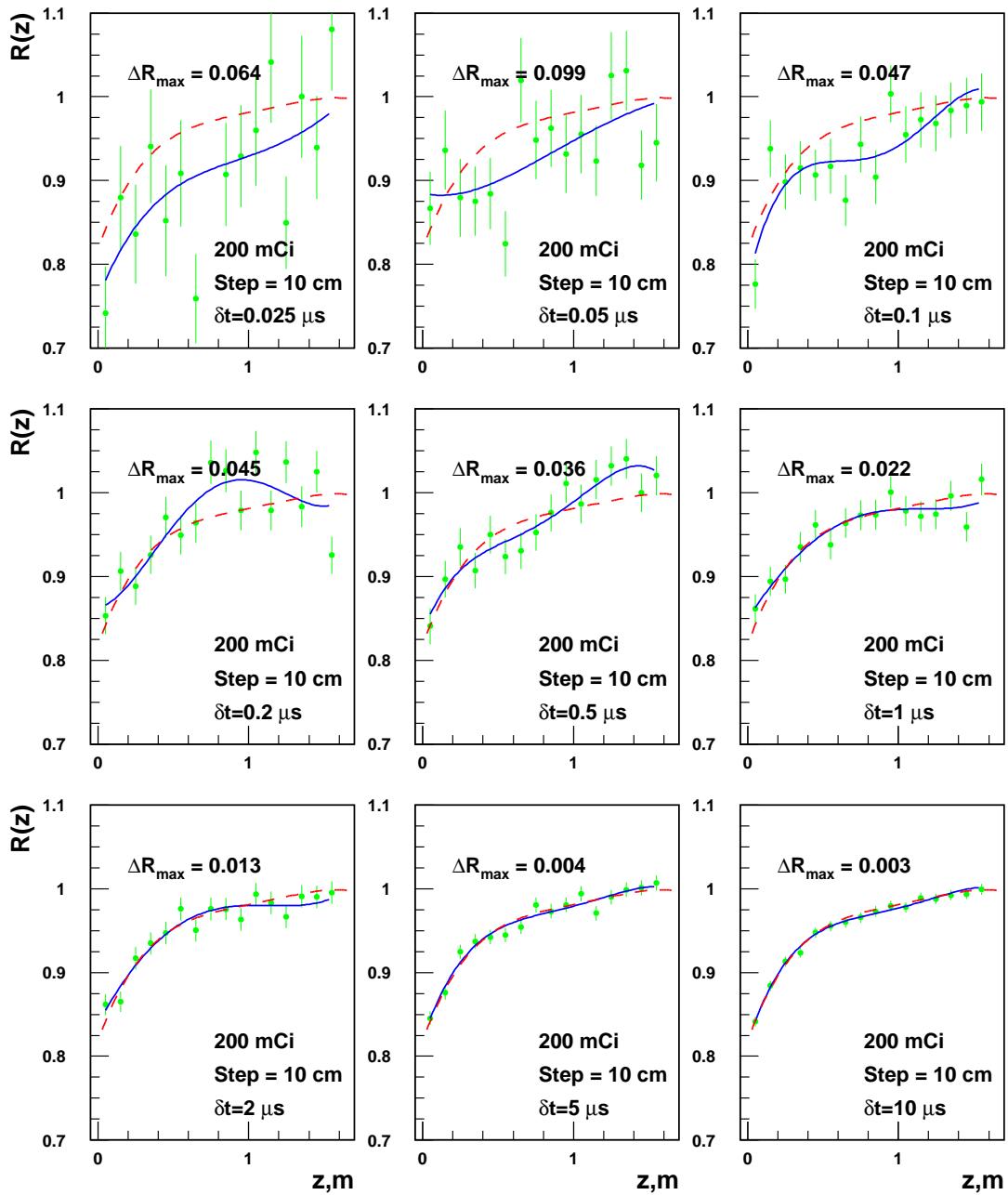
Measurement of the fiber transparency reduction (200 mCi, 10 cm step)



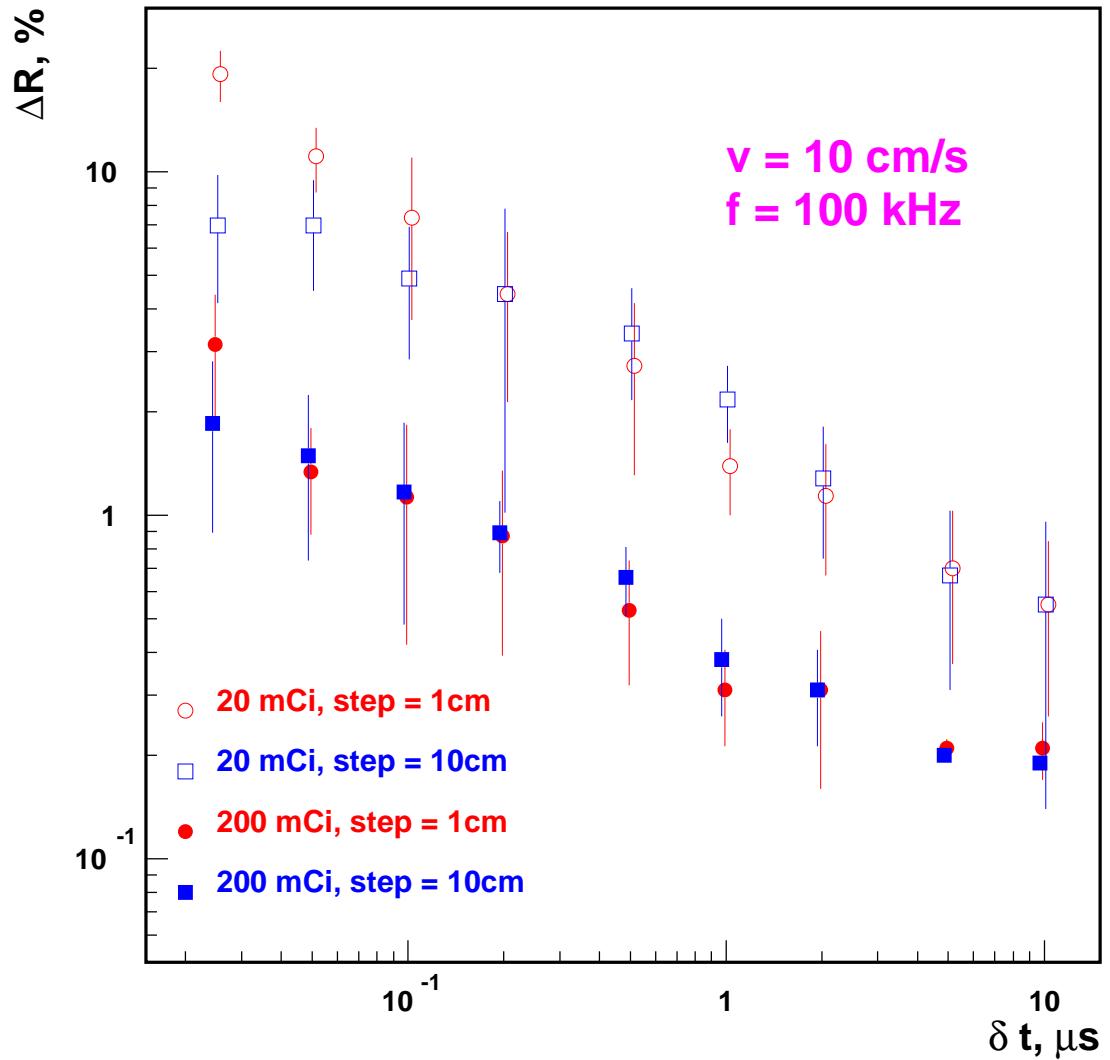
Measurement of the fiber transparency reduction (20 mCi, 1 cm step)



Measurement of the fiber transparency reduction (20 mCi, 10 cm step)



Precision of the complete procedure of measurement

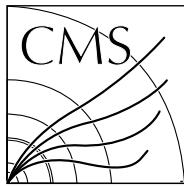


Conclusion:

- standard ADC readout at the using of 20 mCi ^{60}Co does not permit to measure the fiber transparency reduction with a necessary precision during the one source run;
- proposed in the TDR the readout method for source calibration is based on the contiguous time frames of 16 samples (0.26 - 0.40 μs), it permits to measure transparency reduction with 4-7% presicion;

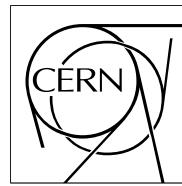
The precision of measurement could be improved more by:

- increasing of the source power, but most probably it is not possible due to safety problems;
- using of the other electronics (as amperemeter or RC charge integrator...);
- increasing of the total time of measurement.



The Compact Muon Solenoid Experiment
CMS Note

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X XXX 2001

Mathematical Simulation
of the CMS HF Calorimeter Calibration
with the Radioactive Source

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Abstract

Operation of the CMS HF calorimeter calibration with the radioactive source was investigated by the Monte-Carlo simulation method. Source signals have been calculated for different HF tower geometries and positions and for two (cobalt and cesium) types of radioactive sources, and expected signal parameters have been analyzed. Radiation background due to the HF absorber activation was taken into account. Complete procedure of the HF re-calibration with the radioactive source has been simulated too, the recommendations for measurement methods and apparatus characteristics have been provided.